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09/822,414	04/02/2001	Hiroya Kirimura	P107351-00011	9442

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ARENT FOX KINTNER PLOTKIN & KAHN, PLLC
SUITE 600
1050 CONNECTICUT AVENUE, N.W.
WASHINGTON, DC 20036-5339

EXAMINER	
SONG, MATTHEW J	

ART UNIT	PAPER NUMBER
1765	4

DATE MAILED: 09/18/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/822,414	Applicant(s) KIRIMURA ET AL.
	Examiner Matthew J Song	Art Unit 1765

T-1)

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____ .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 16-32 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 16-32 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on 02 April 2001 is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☒ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 3
4) ☐ Interview Summary (PTO-413) Paper No(s) _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other.

DETAILED ACTION

Priority

This application filed under former 37 CFR 1.60 lacks the necessary reference to the prior application. A statement reading "This is a divisional of Application No. 09/236,347, filed 1/25/1999." should be entered following the title of the invention or as the first sentence of the specification. Also, the current status of all nonprovisional parent applications referenced should be included.

Claim Objections

1. Claim 30 is objected to because of the following informalities: Claim 30 recites the limitation of 500 keV to 10 keV, the examiner suggests changing 500 keV to 500 eV. Appropriate correction is required.

Claim Rejections - 35 USC § 102

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

3. Claim 16, 18 and 31-32 are rejected under 35 U.S.C. 102(b) as being anticipated by Zhang et al (US 5,578,520).

Zhang et al discloses a method of annealing a semiconductor, as noted in the entire reference, where a multi-chamber apparatus is used so that an amorphous silicon film having

subjected to theremal annealing can be put to a subsequent laser crystallization step without exposing its surface to air (col 6, ln 1-5). Zhang et al discloses a plasma CVD apparatus **2** for depositing amorphous silicon and a chamber **4** to effect therein laser crystallization of the film (col 6, ln 6-67). Zhang et al also discloses a plasma CVD chamber **13** is loaded with a substrate and a CVD formation of an amorphous silicon film with a starting gas of SiH_4 diluted with hydrogen and after the formation of the silicon film, the substrate is transferred to a laser processing chamber and a laser light is emitted into the chamber from a KrF excimer laser, this reads on applicant's energy beam irradiating device, to crystallize the amorphous silicon film (col 7, ln 1-67 and col 8, ln 1-55).

Referring to claim 18 and 31-32, Zhang et al discloses a similar plasma CVD method as applicant, but is silent to an ion beam. It is inherent to a plasma CVD method to have an ion beam emitted to the surface of the substrate during film growth.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

5. Claims 17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zhang et al (US 5,578,520) in view of Fan et al (US 4,309,225).

Zhang et al discloses all of the limitations of claim 17 including a film forming device with a structure that can from the pre-film over a length **2** and an energy beam irradiation device

with a structure that can irradiate the target surface of the substrate over a length (col 8, ln 15-25), as discussed previously in claim 16, except operating the energy beam irradiation device to irradiate the formed pre-film with the energy beam while moving the substrate in a second direction crossing the first direction.

In a method of forming an amorphous material with a moving energy beam, Fan et al teaches how to provide continuous, controlled motion of a crystallization front in an amorphous material by controlling parameters such as the rate at which a laser beam or other beam of energy is moved across an amorphous material (col 2, ln 1-67). Fan et al also discloses scanning of a semiconductor can be achieved by mounting a sample chamber on translational stages **28**,**30** and **32** provide the capability to move the chamber and thus the semiconductor in the x, y, and z directions, this reads on applicant's moving the substrate in a second directions. Fan et al also discloses each stage can be driven separately or simultaneously and the rate at which each stage can be driven is variable (col 4, ln 25-67; col 5, ln 1-67). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Zhang et al with Fan et al to obtain continuous, controlled motion of a crystallization front in an amorphous material.

6. Claims 17, 19 and 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zhang et al (US 5,578,520) in view of Asakawa et al (US 5,795,385).

Zhang et al discloses all of the limitations of claim 17 including a film forming device with a structure that can from the pre-film over a length **2** and an energy beam irradiation device with a structure that can irradiate the target surface of the substrate over a length (col 8, ln 15-25), as discussed previously in claim 16, except operating the energy beam irradiation device to

irradiate the formed pre-film with the energy beam while moving the substrate in a second direction crossing the first direction.

In a method of forming a single crystalline thin film by beam irradiation, Asakawa et al teaches an amorphous substrate using plasma chemical vapor deposition while simultaneously irradiating the substrate with beams of low energy gas (col 4, ln 30-67). Asakawa et al teaches the substrate can be scanned by a substrate moving means, whereby it is possible to from a single crystalline thin film having high homogeneity on a long substrate (col 10, ln 5-45; Eleventh Preferred Embodiment). Asakawa et al also teaches it is possible to facilitate formation of an amorphous thin film by intermittently applying beams from an ion source while regularly supplying a reaction gas and rotating the substrate during application pauses (col 12, ln 1-50). Asakawa et al also teaches neon ions can be accelerated to 200-600 eV by an ion source **83** (col 23, ln 20-55). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Zhang et al with Asakawa et al to form a thin film having high homogeneity on a long substrate.

Referring to claim 19, the combination of Zhang et al and Asakawa et al teaches a pre-film of the crystalline silicon film is formed on the target surface while emitting an ion beam to the substrate in the step of form the pre-film by the film forming device ('385 col 4, ln 50-67).

Referring to claim 23, the combination of Zhang et al and Asakawa et al teaches formation of an amorphous film by intermittently applying beams from an ion source while supplying reaction gas, this reads on applicant's ion beam is emitted to the target surface of the substrate in an initial stage of the forming of the pre-film.

7. Claim 21, 23, 25 and 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zhang et al (US 5,578,520) in view of Asakawa et al (US 5,795,385) or Fan et al (US 4,309,225) as applied to claim 17 above, and further in view of Selvakumar et al (US 5,633,194).

The combination of Zhang et al and Asakawa et al or the combination of Zhang et al and Fan et al teaches all of the limitations of claim 21, as discussed previously in claim 17, except the silicon film forming vacuum chamber is further provided with an ion source, an ion beam is emitted to the target surface of the substrate from the ion source prior to the step of forming the pre-film

In a method of forming epitaxial grown Si utilizing ion beams (col 1, ln 35-65), Selvakumar et al teaches in-situ cleaning of a substrate surface by argon ion bombardment prior to the start of deposition, where a 200 eV argon ion beam was used to sputter clean the substrate in a necessary step which significantly influences the quality of a grown film by removing native oxide. Selvakumar et al also discloses an inexpensive ion beam vapor deposition technique used to grow silicon films, where an ion source **13** was used to ionize a gas to accelerate an ion beam towards a substrate with a current between 30-1000 eV using high purity argon and silane gases as sources for the ion beam (col 6, ln 20-65; col 7, ln 1-67). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Zhang et al and Asakawa et al with Selvakumar et al to clean the substrate.

Referring to claim 30, the combination of Zhang et al, Asakawa et al and Selvakumar et al does not teach an emission energy of 500 eV to 10 keV. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Zhang

et al, Asakawa et al and Selvakumar et al by optimizing the emission energy by conducting routine experimentation of a result effective variable.

8. Claims 18, 20, 22, 26-29 and 31-32 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zhang et al (US 5,578,520) in view of Selvakumar et al (US 5,633,194).

Zhang et al discloses all of the limitations of claim 18, as discussed previously in claim 16, except the silicon film forming vacuum chamber is further provided with an ion source, an ion beam is emitted to the target surface of the substrate from the ion source prior to the step of forming the pre-film.

In a method of forming epitaxial grown Si utilizing ion beams (col 1, ln 35-65), Selvakumar et al teaches in-situ cleaning of a substrate surface by argon ion bombardment prior to the start of deposition, where a 200 eV argon ion beam was used to sputter clean the substrate in a necessary step which significantly influences the quality of a grown film by removing native oxide. Selvakumar et al also discloses an inexpensive ion beam vapor deposition technique used to grow silicon films, where an ion source **13** was used to ionize a gas to accelerate an ion beam towards a substrate with a current between 30-1000 eV using high purity argon and silane gases as sources for the ion beam (col 6, ln 20-65; col 7, ln 1-67). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Zhang et al with Selvakumar et al to clean the substrate.

Referring to claim 26, the combination of Zhang et al and Selvakumar et al is silent to an emission energy of the ion beam is in a range from 100 eV to 1 keV. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of

Zhang et al and Selvakumar et al to have an energy in the range from 100 eV to 1 keV by optimizing the emission energy by conducting routine experimentation because thin films exhibiting various crystallinity from single crystal silicon to amorphous silicon are dependent on the irradiation energy to the substrate can be deposited on the silicon substrate.

Referring to claim 27, the combination of Zhang et al and Selvakumar et al teaches an ion beam where a current can be adjusted between 30-1000 eV and a cleaning at 200 eV. The combination of Zhang et al and Selvakumar et al does not teach an emission energy of 500 eV-10 keV. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Zhang et al and Selvakumar et al by optimizing the emission energy by conducting routine experimentation of a result effective variable.

Referring to claim 28, the combination of Zhang et al and Selvakumar et al does not teach an emission energy in a range from 500 eV to 10 keV. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Zhang et al and Selvakumar et al by optimizing the emission energy by conducting routine experimentation of a result effective variable to obtain same.

Referring to claim 29, the combination of Zhang et al and Selvakumar et al does not teach an emission energy in a range from 2 keV to 10 keV. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Zhang et al and Selvakumar et al by optimizing the emission energy by conducting routine experimentation of a result effective variable to obtain same.

Referring to claims 31-32, the combination of Zhang et al and Selvakumar et al teaches plasma CVD using silicon contained gas and hydrogen.

9. Claims 18, 20, 22, 24, 26-29 and 31-32 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zhang et al (US 5,578,520) in view of Ichikawa et al (US 5,484,746).

Zhang et al discloses all of the limitations of claim 20, as discussed previously in claim 16, except the silicon film forming vacuum chamber is further provided with an ion source, an ion beam is emitted to the target surface of the substrate from the ion source prior to the step of forming the pre-film.

In a process of forming a semiconductor thin film, Ichikawa et al teaches cleaning surface adherents is performed by use of ions controlled in magnitude of energy (i.e. claim 20) and it is desirable that the surface cleaning step and the later deposition step of an amorphous semiconductor layer should be performed continuously so that no contaminant may be adsorbed. Ichikawa et al also teaches removing surface adherents with ions has been realized within sputtering apparatus in the form of cleaning of a silicon surface with argon ions, this reads on applicant's ion beam is emitted to the target surface prior to the step of forming the pre-film, and by performing sputtering film formation in the same apparatus immediately after the cleaning step, thin films exhibiting various crystallinity from single crystal silicon to amorphous silicon which are dependent on the irradiation energy to the substrate can be deposited on the silicon substrate (col 3, ln 1-67). Ichikawa et al also teaches sputtering a target is caused to occur by irradiations of argon (i.e. claim 18) and a power source **109** for supplying energy in the cleaning step (col 4, ln 1-67). Ichikawa et al also teaches sputter cleaning of a semiconductor with argon has been also used as the pre-treatment of low temperature silicon epitaxial growth by CVD with argon ions generally more than 100 eV are used at a lowered processing temperature (col 1, ln

20-67; col 2, ln 1-45). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Zhang et al with Ichikawa et al to remove surface adherents from a substrate

Referring to claim 22, the combination of Zhang et al and Ichikawa et al teaches an ion source in an initial stage of the step of forming the pre-film by the film forming device (col 3, ln 10-35).

Referring to claim 24, the combination of Zhang et al and Ichikawa et al teaches cleaning with an ion beam and sputtering with an ion beam continuously, this reads on applicant's ion beam is emitted to the target surface of the substrate during a period from a stage before the pre-film forming step and forming device to an initial stage of the pre-film forming step.

Referring to claim 26-29, the combination of Zhang et al and Ichikawa et al does not teaches the emission energy of the ion beam. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Zhang et al and Ichikawa et al by optimizing the emission energy of the ion beam by conducting routine experimentation of a result effective variable.

Referring to claims 31-32, the combination of Zhang et al and Ichikawa et al teaches plasma CVD with silicon containing gas and hydrogen.

10. Claims 21, 23, 25 and 30-31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zhang et al (US 5,578,520) in view of Fan et al (US 4,309,225) as applied to claim 17 above, and further in view of Ichikawa et al (US 5,484,746).

The combination of Zhang et al and Fan et al discloses all of the limitations of claim 21, as discussed previously in claim 17, except emitting an ion beam to a target surface of a substrate prior to the step of forming the pre-film by the film forming device.

In a process of forming a semiconductor thin film, Ichikawa et al teaches cleaning surface adherents is performed by use of ions controlled in magnitude of energy (i.e. claim 20) and it is desirable that the surface cleaning step and the later deposition step of an amorphous semiconductor layer should be performed continuously so that no contaminant may be adsorbed. Ichikawa et al also teaches removing surface adherents with ions has been realized within sputtering apparatus in the form of cleaning of a silicon surface with argon ions, this reads on applicant's ion beam is emitted to the target surface prior to the step of forming the pre-film, and by performing sputtering film formation in the same apparatus immediately after the cleaning step, thin films exhibiting various crystallinity from single crystal silicon to amorphous silicon which are dependent on the irradiation energy to the substrate can be deposited on the silicon substrate (col 3, ln 1-67). Ichikawa et al also teaches sputtering a target is caused to occur by irradiations of argon (i e. claim 18) and a power source **109** for supplying energy in the cleaning step (col 4, ln 1-67). Ichikawa et al also teaches sputter cleaning of a semiconductor with argon has been also used as the pre-treatment of low temperature silicon epitaxial growth by CVD with argon ions generally more than 100 eV are used at a lowered processing temperature (col 1, ln 20-67; col 2, ln 1-45). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Zhang et al and Fan et al with Ichikawa et al to remove surface adherents from a substrate

Referring to claim 23, the combination of Zhang et al, Fan et al and Ichikawa et al teaches an ion source in an initial stage of the step of forming the pre-film by the film forming device (' 746 col 3, ln 10-35).

Referring to claim 25, the combination of Zhang et al, Fan et al and Ichikawa et al teaches cleaning with an ion beam and sputtering with an ion beam continuously, this reads on applicant's ion beam is emitted to the target surface of the substrate during a period from a stage before the pre-film forming step and forming device to an initial stage of the pre-film forming step.

Referring to claim 30 as interpreted by the examiner, the combination of Zhang et al, Fan et al and Ichikawa et al does not teach the emission energy of the ion beam is in a range from 500 eV to 10 eV. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Zhang et al, Fan et al and Ichikawa et al by optimizing the emission energy by conducting routine experimentation because thin films exhibiting various crystallinity from single crystal silicon to amorphous silicon which are dependent on the irradiation energy to the substrate can be deposited on the silicon substrate

Referring to claims 31-32, the combination of Zhang et al, Fan et al and Ichikawa et al teaches plasma CVD with silicon containing gas and hydrogen.

11. Claims 22 and 28-29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zhang et al (US 5,578,520) in view of Krimmel (US 4,140,546).

Zhang et al discloses all of the limitations of claim 22, as discussed previously in claim 16, except an ion beam is emitted to the target surface of the substrate from an ion source in an initial stage of the step of forming the pre-film by the film forming device.

In a method of producing a monocrystalline layer of a substrate (col 1-8), Krimmel teaches an electron beam vaporizer means may be utilized to produce a vapor flux of a material being deposited and to produce an ion flux which contains ions composed of a material being vapor deposited (col 4, ln 20-50). Krimmel also teaches a silicon substrate **6**, vaporizing material, which is deposited on the substrate and simultaneously ions are accelerated to the surface of the substrate, this reads on applicant's initial stage of forming the pre-film (col 5, ln 10-55). Krimmel also teaches an ion flux having an energy of 10 keV (claim 1). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Zhang et al with Krimmel's ion beam to increase adhesive strength and increase a corrosion barrier for the material grown (col 3, ln 25-40).

Conclusion

12. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Copel et al (US 5,997,638) teaches sputter cleaning a silicon substrate with argon ion with an energy of 1 keV (col 9, ln 5-60).

Asano (US 5,409,867) teaches placing a sample on a movable stage of XY two axes and crystallizing an amorphous layer with a laser while moving the substrate (col 2-3).

Muranaka et al teaches a plasma CVD method highly reactive ions and radials having higher internal energy present in the plasma activate a reaction on the growing surface and high energy ions ($20\text{-}10^3$ eV) ions (i.e. claim 26) to the substrate during thin film growth (col 1, ln 45-67).

Asia et al (US 5,365,875) teaches irradiation energy is a result effective variable for plasma CVD depositions (col 10-11).

13. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J Song whose telephone number is 703-305-4953. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Benjamin L Utech can be reached on 703-308-3868. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9310 for regular communications and 703-872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

Matthew J Song
Examiner
Art Unit 1765

MJS
September 16, 2002

BENJAMIN L. UTECH
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 1700